Preserving the Astronomical Sky
IAU Symposium, Vol. 196, 2001
R. J. Cohen and W. T. Sullivan, III, eds.

Measurements of Radio Interference at Solar Radio Stations in Beijing

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Abstract. Shahe Station of our Solar Radio Group has suffered from radio interference in recent years, so we decided to move our solar radio telescopes to Huairou Station of BAO. We measured radio interference at both sites recently and found that the radio interference is more serious in Shahe than in Huairou. Although the interference is low at the single working frequency, we do find some radio interference within the working band at Shahe. It is comparatively radio quiet at Huairou and suitable for placement of the solar radio instruments there.

1. Introduction

The study of solar radio astronomy at Beijing Astronomical Observatory (BAO) began in 1959 when a solar radio telescope at 3.2 cm wavelength made in the former Soviet Union was sent to BAO after the observing campaign at Hainan Island in south China by a Joint China-Soviet Union Eclipse Team. Later the antenna was returned to the Soviet Union and in the early 1960s, the first solar radio telescope made at home with a 3.2 cm wavelength calibration system was developed and put into operation at Shahe Station for predictions of solar activity. A solar radio flux observing system at 10 cm wavelength was established in 1970 and began measurements at Shahe Station. Then the Solar Radio Group began to study rapid variations of solar radio emission and in 1981, a solar radio fast recording system at 2840 MHz with a temporal resolution of 1 ms was put into operation (Zhao & Jin 1982, Jin et al. 1986). Since 1983 it has served as an important element in a network all over the country for observing solar radio emission simultaneously with high temporal resolution, and considerable achievements have been made in the 22nd solar cycle. In January 1993, a solar radio observing system was established at Zhongshan Station in Antarctica.

Since 1994, we have been developing a broadband solar radio spectrometer with a frequency coverage of 0.7-7.6 GHz, a frequency resolution of 1-10 MHz, and a temporal resolution of 1-10 ms (Fu et al. 1995). This instrument is composed of 5 spectrometers, covering 0.7-1.4 GHz, 1.0-2.0 GHz, 2.6-3.8 GHz,

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4.0-5.2 GHz, and 5.2-7.6 GHz. The three spectrometers at 1.0-2.0 GHz, 2.6-3.8 GHz, and 5.2-7.6 GHz are located at Shahe Station. The other two are located in two cities: Kunming and Nanjing, about 2000 km and 1000 km away from Beijing, respectively. The 1.0-2.0 GHz spectrometer has been in operation since January 1994 and the one at 2.6-3.8 GHz since September 1996. The other parts are scheduled to finish this year. At present, we routinely provide solar radio observations at 2840 MHz for inclusion in *Chinese Solar-Geophysical Data* published by Beijing Astronomical Observatory, and in part II of *Solar-Geophysical Data* published by National Geophysical Data Center at Boulder, Colorado.

Shahe Station has suffered from radio interference in recent years and we decided to move our solar radio telescopes to Huairou Solar Observing Station of BAO, about 50 km away in a northern suburb of Beijing. We measured radio interference at both sites recently and found that the radio interference is more serious in Shahe than in Huairou. Although the interference is low at our single working frequency, we do find some radio interference within our working band. It is comparatively radio quiet in Huairou and suitable for operation of the solar radio instruments there. Here we report the measurements and analyses of the radio interference at Shahe and Huairou Stations. In Section 2 we describe the measurements and introduce the instruments and their performance, and in Section 3 we analyze the radio interference at both sites and discuss its influence.

2. Measurements and Instruments

2.1. Instruments

The measurements of radio interference at Huairou and Shahe Stations of the BAO were conducted on 9 and 10 December, 1998, respectively. Figure 1 shows the location of both stations and the diagram of the testing system. The characteristics of the testing system are listed in Table 1.

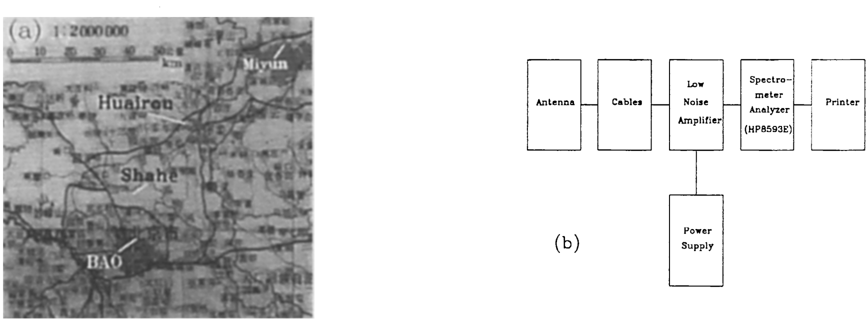

Figure 1. (a) Locations of the Headquarters of BAO, as well as Shahe and Huairou Stations. (b) Block diagram of the testing system.

2.2. Interference Measurements

Firstly, all instruments were connected according to the system diagram shown in Figure 1. At Huairou Station, the antenna was mounted on the top flat of

https://doi.org/10.1017/S0074180900164289 Published online by Cambridge University Press

Table 1. Performance of the testing system

Item	Type	Frequency range	Performance
Log-periodic dipole antenna	LPDA-9531	0.2-1.0 GHz	gain: -18 dB to +6 dB
Parabolic reflector antenna	1m diameter	1.0-2.0 GHz 2.0-4.0 GHz 4.0-8.0 GHz	gain: 20 dB gain: 28 dB gain: 30 dB
Cable losses		all band	~ 3 dB
Low Noise Amplifier (LNA)		0.2-1.0 GHz 1.0-2.0 GHz 2.0-4.0 GHz 4.0-8.0 GHz	gain: 50 dB; noise: 1 dB gain: 50 dB; noise: 1 dB gain: 50 dB; noise: 1 dB gain: 50 dB; noise: 1 dB
Spectrometer Analyzer	HP8593E	Sensitivity: -109 dBm (at 10 KHz resolution)	

the tower of the Solar Magnetic Field Telescope, whereas at Shahe Station, it was mounted on the roof of a two-story building. Before measuring the radio interference the self-testing procedure of the system was executed to ensure that the system was in good order. Then the elevation of the antenna was adjusted to 0 degrees. For each frequency band the antenna was scanned at 5 degree intervals in azimuth, and the maximum radio interference was carefully identified and recorded. The horizontal and vertical polarizations were measured repeatedly at these maximum values of the interference.

3. Analysis of the Radio Interference

More than 60 plots of the original radio spectral distributions were thus obtained and are collected in a technical report (1998). Figure 2 shows the radio interference measured at Shahe and Huairou stations. Interference mainly comes from cellular communications below 1 GHz, the Multichannel Microwave Distribution System (MMDS) around 2.6 GHz, and other microwave interference from Beijing and Huairou county's directions. Fortunately the MMDS for cable TV in Beijing is to be replaced by a fibre-optic system, which might improve the situation in this band. It is comparatively radio-quiet at Huairou and suitable for operation of the solar radio instruments there. The influence of radio interference on the solar radio observations and the measures to reject or eliminate it are discussed in Yan et al. (2001).

A document entitled "Interference Protection Criteria for Frequencies used by the Radio-astronomy Service" has been drafted for several years, but it is still not approved to become a national standard in China. We hope that the present concern to preserve the astronomical sky may help China to have its first national standard on frequency protection for radio astronomy.

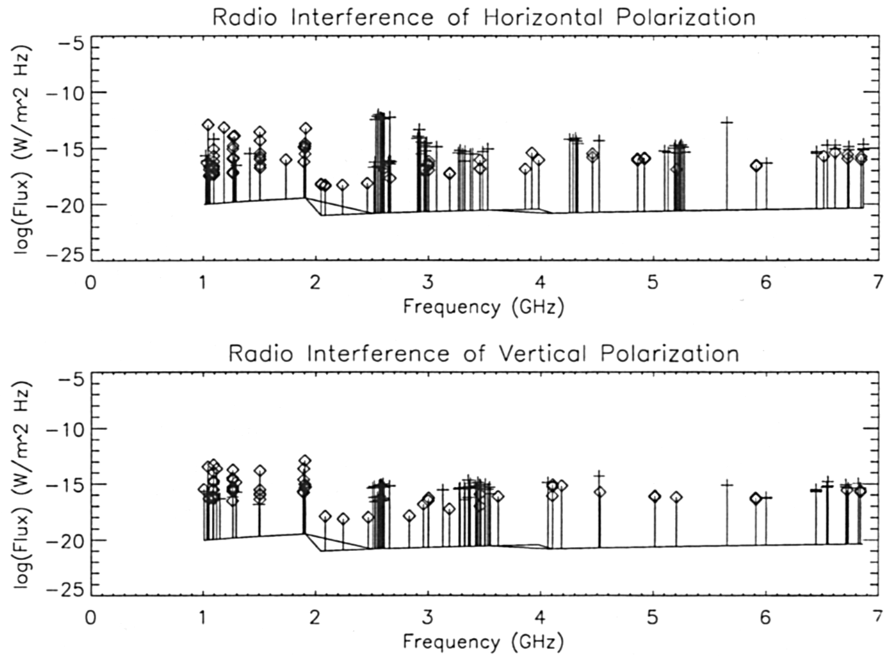

Figure 2. Flux of vertical and horizontal polarizations of radio interference measured at Shahe (+) and Huairou (⋄) Station.

Acknowledgments. The Solar Radio Broadband Dynamic Spectrometer is supported by CAS and NNSF of China. We acknowledge Profs. Chen H., Ji H. and Piao T. for kind help. The measurement of radio interference was pursued by the Technical Service of NRMC of China under a Contract with the Solar Radio Group of BAO.

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https://doi.org/10.1017/S0074180900164289 Published online by Cambridge University Press